Focus on Apatite

Blocking strontium from reaching the Columbia River

Strontium-90 in groundwater poses a threat to human health and the environment. The strontium at Hanford will pose a risk for many generations.

What is apatite?

Apatite is the name of a common type of mineral. Apatite minerals have the ability to capture and hold radioactive and metal contaminants. Large amounts of apatite are in bones and smaller amounts are in rocks. Apatite and apatite-like minerals make up most of our teeth and bones.

Apatite has many uses. Often, apatite is used in fertilizers because it is a rich source of phosphorus. Sometimes apatite is used in gems for jewelry. It has a hardness rating of 5 on a scale where talc has a hardness of 1 and diamond has a hardness of 10. Apatite also is used to fluoridate water and to put protective coatings on metals to prevent rust.

Apatite minerals are very stable and do not readily dissolve in the natural environment.

What is the problem?

Soil and groundwater near the Hanford Site's 100-N Reactor are contaminated with large amounts of strontium-90, a radioactive form of strontium.

The N Reactor was the last and the largest reactor to make plutonium for the nation's nuclear weapons program. In the reactor, cooling water became contaminated as it circulated around the nuclear fuel rods. Cooling water also became contaminated in the storage basins for irradiated fuel. Millions of gallons of cooling water from the reactor and storage basins were discharged to the ground into two unlined trenches near the shoreline. Discharges to the ground near N Reactor ended in 1992.

Strontium-90 in groundwater poses a threat to human health and the environment. It is not only radioactively toxic, it also mimics calcium by replacing it in bones and plants. If enough strontium-90 builds up in a body, it can cause cancer in bones, skin, and blood (leukemia). Because it lodges in bones, strontium-90 damage can lead to anemia, abnormal bleeding, and inability to fight diseases.

Strontium-90 has a half-life of 29 years. This means every 29 years half of its remaining radioactivity decays away. It takes 10 half-lives for a radioactive material to decay completely away. The strontium at Hanford will pose a risk for many generations.

The apatite will be injected into the Columbia River shoreline near N Reactor. As the groundwater moves toward the river, the apatite will absorb strontium-90 and prevent it from reaching the river.

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What is the plan?

In short, apatite will remove strontium-90 from the groundwater entering the Columbia River. The test plan calls for pumping apatite into the soil column near the shoreline when the river is highest. The strontium concentrations are highest within several feet of the water table. When the river rises, the groundwater also rises, picking up more strontium. Hanford scientists want to study whether the apatite will form in intermittently wet and dry soil.

Results should be clear within several weeks. Scientists will learn if the barrier is working by monitoring strontium levels in test wells. Later, they will take a core sample of the barrier to see if it has captured strontium.

Next, test zones will be expanded and injections made to deeper layers of the soil column. This creates an apatite barrier across a long section of the contaminated shoreline.

How will apatite help in Hanford's cleanup?

The Washington State Department of Ecology (Ecology) and U.S. Department of Energy (USDOE) have explored many new and existing technologies to address strontium in the soil and groundwater to prevent its migration to the Columbia River. The use of apatite is one of the newer technologies that Ecology proposed for more study.

Apatite chemically attracts strontium. In 2004 and 2005, scientists at Hanford looked at using apatite to isolate or capture the strontium in the soil. Scientists call this process "sequestration." Laboratory and small-scale tests yielded good results.

Hanford groundwater protection experts believe the apatite will bind up strontium. The apatite will absorb into its crystals any strontium it contacts, which will lock up that strontium and remove it from the groundwater. These crystals will continue to remove strontium, holding it in place for the decades it takes to decay to harmless levels.

What other efforts have been tried to keep strontium from reaching the river?

Efforts to remove strontium-90 from the groundwater began in 1995 with pump-and-treat systems. These systems pumped groundwater to the surface, removed the strontium-90, and returned the clean water to the aquifer.

Unfortunately, these efforts were not successful in lowering the levels of strontium at the shoreline. While the systems removed strontium from the groundwater, the strontium in the soil re-contaminates the groundwater again and again. The pump-and-treat system is shut down to carry out the apatite tests.

In addition to pump-and-treat efforts, USDOE tried to insert an underground metal barrier along the shoreline to intercept strontium migration to the river. Hanford scientists also studied the idea of freezing the aquifer and flushing the soil. These efforts did not succeed.